

AIR POLLUTION RESEARCH

October 29, 2004

California Environmental Protection Agency



Air Resources Board

Presentation Overview

- **Research Program Overview**
- Strategic Plan for Research, 2001-2010
- Planned Air Pollution Research, FY 2004/05

Research Program Overview

- Established by Health and Safety Code, 1971
- Basis for regulatory actions
- Overseen by Research Screening Committee
- Managed by ARB's technical staff

Role of Research Screening Committee

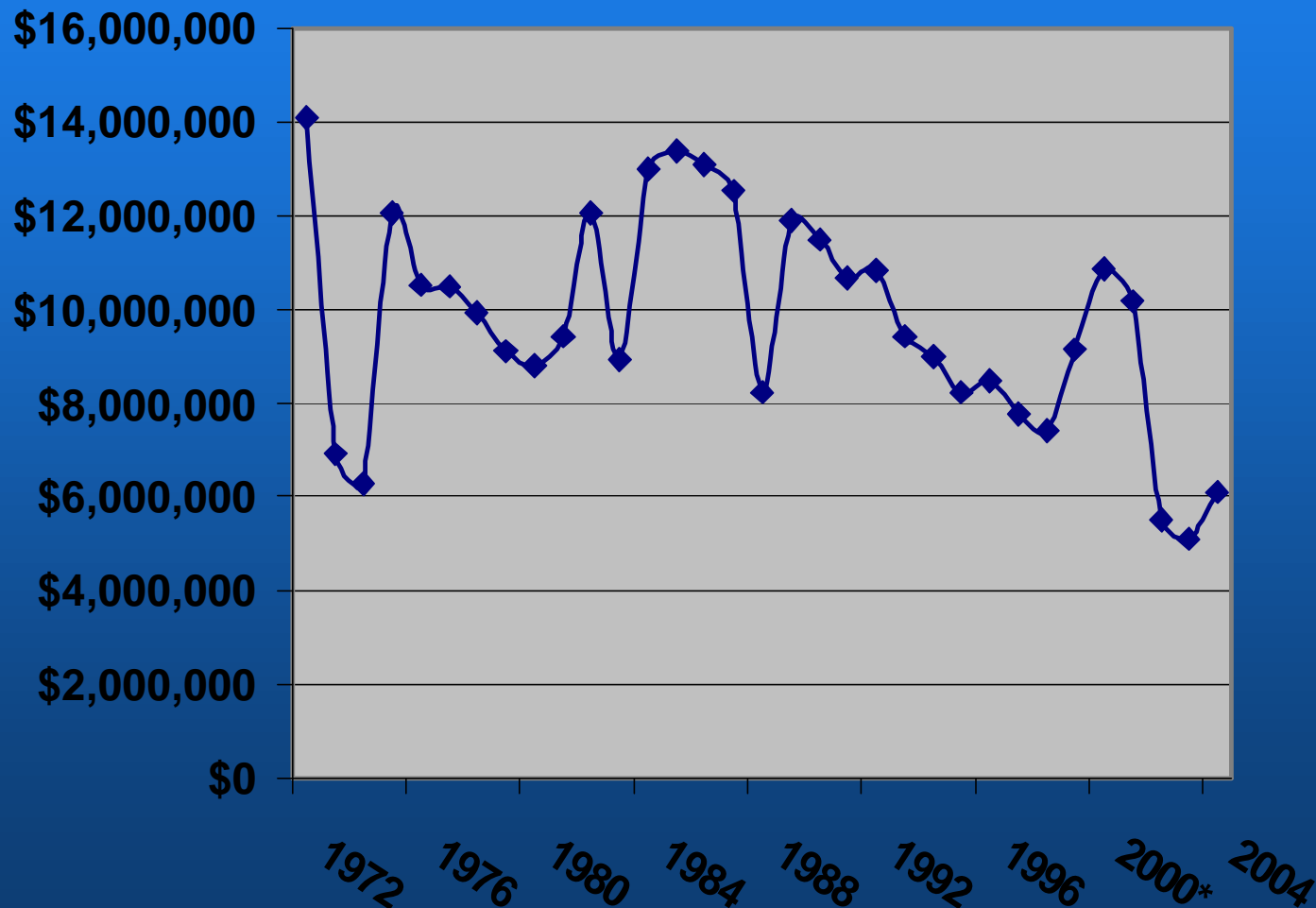
On behalf of the Board:

- Provides guidance on research plans
- Reviews and provides technical comments on:
 - Research proposals
 - Final reports
 - Other aspects of the research work

Role of the Board

- Appoint RSC members
- Review and approve research plans
- Approve funding of research proposals

Research Program Budget History*



*constant 2004 dollars

Cofunding Organizations

- California Energy Commission
- South Coast Air Quality Management District
- U.S. Environmental Protection Agency
- National Institute of Environmental Health Sciences

Collaborating Organizations

- Coordinating Research Council
- Health Effects Institute
- Industry Groups

Research Mechanism

- Extramural Research
- In-house Research
- Technology Development

Recent In-house Research

Major areas include:

- Health and economic benefits from air pollution control
- Lake Tahoe Atmospheric Deposition Study
- In-vehicle and near sources measurements and exposure assessments
- Engine emissions, fuel effects, and control technology
- Asian dust transport

Innovative Clean Air Technologies (ICAT)

- Funds demonstrations of technologies
- Matching funds required
- Benefits of helping new technologies
 - Better emission control
 - Lower costs
 - Create jobs (~ 100 per \$1 million spent)
 - Create tax revenues (\$2 to \$7 each year per \$ spent)

Presentation Overview

- Research Program Overview
- **Strategic Plan for Research, 2001-2010**
- Planned Air Pollution Research, FY 2004/05

Strategic Plan for Research 2001-2010



**10-year roadmap
for
air pollution
research**

Objectives

- Reduce Emissions and Exposure to Particulate Matter
- Characterize and Reduce Community Exposure to Air Pollutants
- Promote Zero and Near-Zero Emission Technologies

Regulatory and Policy Drivers

- Ambient Air Quality Standards
- Environmental Justice Program
- State Implementation Plans
- Diesel Risk Reduction Plans
- Climate Change (AB 1493)

Categories

- Health and Welfare Effects
- Exposure Assessment
- Technology Advancement and Pollution Prevention
- Global Air Pollution

Strategic Plan Presentation

For each category:

- Specific research areas
- Key research questions
- Landmark projects
- Major on-going projects

Health and Welfare Effects



Research Areas

- Human Health Effects
- Lake Tahoe and Other Ecosystems
- Regional Haze
- Benefits and Costs of Air Pollution Control

Some Key Research Questions

- What are the key components and characteristics of PM that contribute to adverse health effects?
- What members of society are most vulnerable to air pollution's harmful effects?
- What are the health effects of long-term exposures?

Landmark projects...

Health and Welfare

Children's Health Study

Long-Term Effects of Air Pollution

Annual health assessments of 5500 children

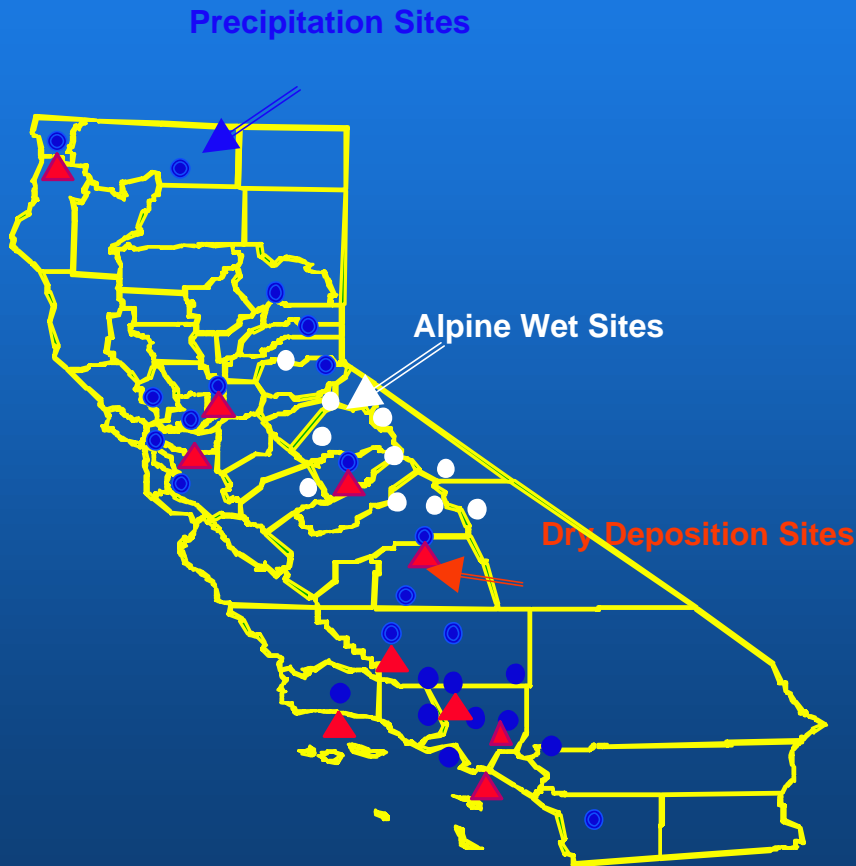
Findings

- Lung growth reduced in PM and NO₂ polluted cities
- Children's lung capacity may not reach normal potential in polluted cities
- Re-enforced by observation normal growth rates in children who move to clean air communities
- New asthma detected in children who exercise in high ozone cities
- School absenteeism increased with increased ozone

Supporting Air Quality Standards

- Human clinical studies in '80 and '90s
- Focussed on establishing lowest effects levels and mechanisms of injury
- Pollutants researched:
 - Ozone
 - Nitrogen Dioxide
 - Sulfur Dioxide
 - Carbon Monoxide
 - Particulate Matter

California Acid Deposition Program



- The research added valuable information on acid deposition
- Absent certainty of chronic health effects, there is no immediate need for an air quality standard
- Controls for ozone, PM₁₀, and NO₂ have reduced acid deposition

Regional Haze



- California standard for Visibility Reducing Particles (VRP) adopted 1969, updated 1989; applies Statewide.
- Equivalent to Visual range of 10 mi.; 30 mi. at Lake Tahoe
- Major Research:
 - Quantify visibility in all Air Basins
 - Assess economic impacts (property values, flight operations).
- Attainment expected to coincide with State PM₁₀ Std. attainment in most areas.

Benefits and Cost of Air Pollution Control

Developed model to assess impact of regulations on California economy (E-DRAM)

- Assess effects of greenhouse gas regulation (AB 1493)
- Assess effects of State Implementation Plan

Characterized contribution of air pollution control industry to California's economy

- Created 32,000 jobs per year
- Generated \$6.2 billion in revenues per year

Determined annual health benefits of air pollution control

- 7,000 premature deaths
- 7,000 hospitalization admissions
- 3.3 million lost work days

Major On-going Projects

Long-term Health Effects

- Cardiovascular disease in a teachers' cohort

Vulnerable Populations

- Fresno Asthmatic Children's Environment Study

Ultrafine PM

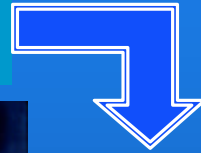
- Particle concentrator and inhalation health study
- Ultrafine particulate matter & cardiorespiratory health

Health Benefits

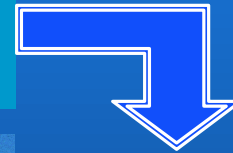
- Quantify health benefits of improvements in air quality

Exposure Assessment

Sources



Transformation
-Transport



Exposure



Research Areas

- Personal and Indoor Exposure
- Emission Inventory
- Atmospheric Processes and Modeling
- Multimedia Effects

Some Key Research Questions

- How do indoor and outdoor sources of air pollution affect indoor and personal exposures?
- Are people at the lower end of the socioeconomic scale exposed to higher levels of pollutants?
- How are emissions transformed in the atmosphere and how do these reaction products impact atmospheric processes?

Landmark projects...

Exposure Assessment

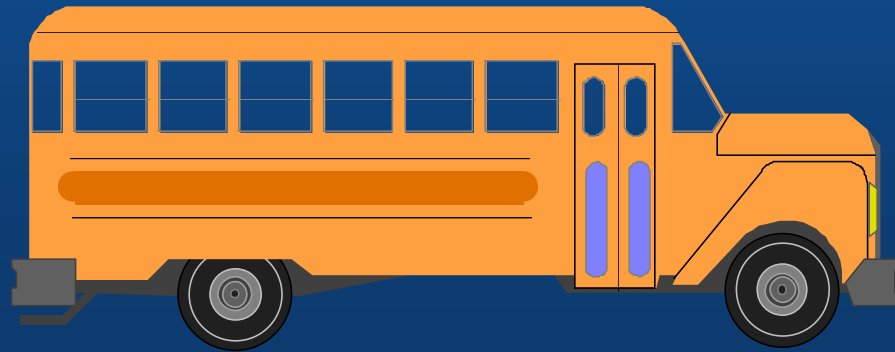
Portable Classrooms Study

- Statewide classroom survey:
 - Formaldehyde too high in many classrooms
 - Noise levels exceeded guideline level in all classrooms
 - Ventilation inadequate 42% of the time
 - Moisture and mold problems due to water leaks and condensation
- Many low cost solutions available



School Bus Study Results

- Results
 - Source of high exposures to vehicle-related pollutants
 - Self-pollution by own bus exhaust
 - Exposure influenced by vehicles being followed (bus carvanning should be restricted)
- Active outreach to provide guidance to schools



Emission Inventory Improvement

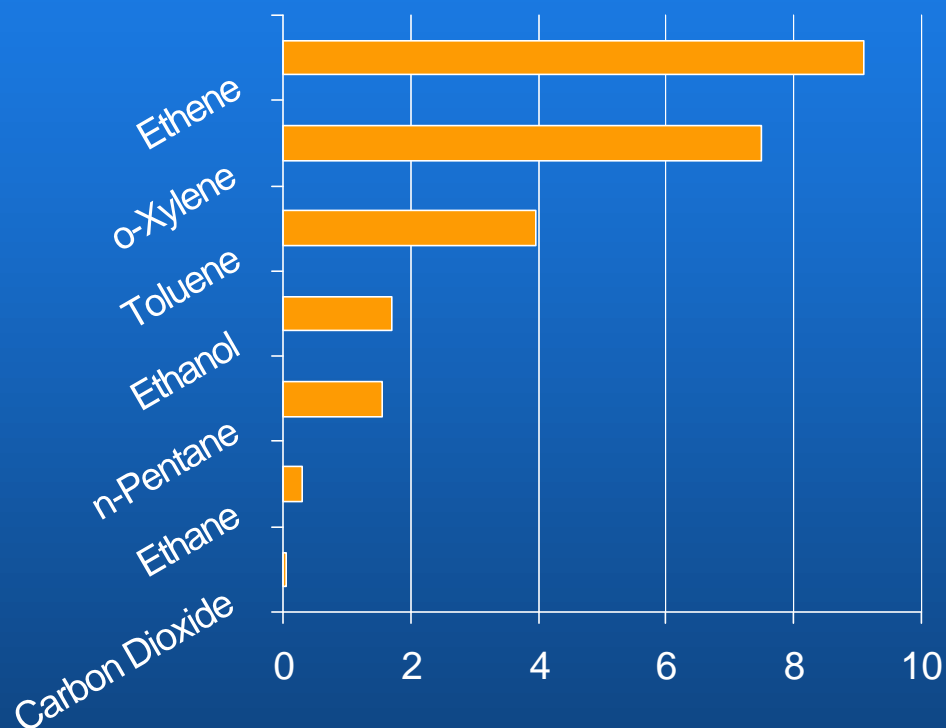
Motor Vehicle

- Measured MV Emissions Trends (1994 - 1997) in the Caldecott Tunnel
- Remote sensing proved able to identify high-emitting vehicles - adjunct to the Smog Check program.

Other

- Biogenic hydrocarbon emissions through Geographic Information Systems (BEIGIS)
- Passive measurements of ammonia emissions
- Generation of sea-salt chlorine inventory

Ozone-forming Potential of VOCs



Grams Ozone per Gram VOC

Results:

- Peer-reviewed reactivity scale - 772 VOCs
- Validation with AQ models

Regulatory Applications:

- Low-Emission Vehicles and Clean Fuels - alternative fuels
- Aerosol Coatings - product limits

Southern California Field Studies



- Aerosol Characterization Experiment (1972)
- Southern California Air Quality Study (1987)
- Southern California Ozone Study-NARSTO (1997)



Major On-going Projects

- CEC-funded indoor exposure studies
 - Ventilation characteristics in new homes
 - Emissions from office machines
 - Classroom ventilation and air quality
- Improved reactivity estimates for architectural coatings
- Sources of fine and ultrafine particles in California

Technology Advancement and Pollution Prevention



Fuel Cell Unit from H Power Corporation

Research Areas

- Clean Air Technologies
- Distributed Generation

Some Key Research Questions

- How can we provide better monitoring methods and increase the accuracy of our measurements and interpretation of data?
- In what areas do we need to support the development of new and innovative technologies?
- What can be done to facilitate the development and deployment of zero and near-zero emission DG technologies?

Landmark projects...

Technology Advancement

Electric Vehicle Charging Station at Airports



- Operational cost saving
- No need to upgrade electrical service
- No detriment to operations
- More systems being installed
- Eliminate vehicular emissions

Diesel Emission Control System



- Reliable regeneration independent of exhaust temperature.
- Consistency in maintaining low engine back pressure
- High performance, removes up to 90% soot
- Low energy consumption

Ultra-Low NO_x Burner

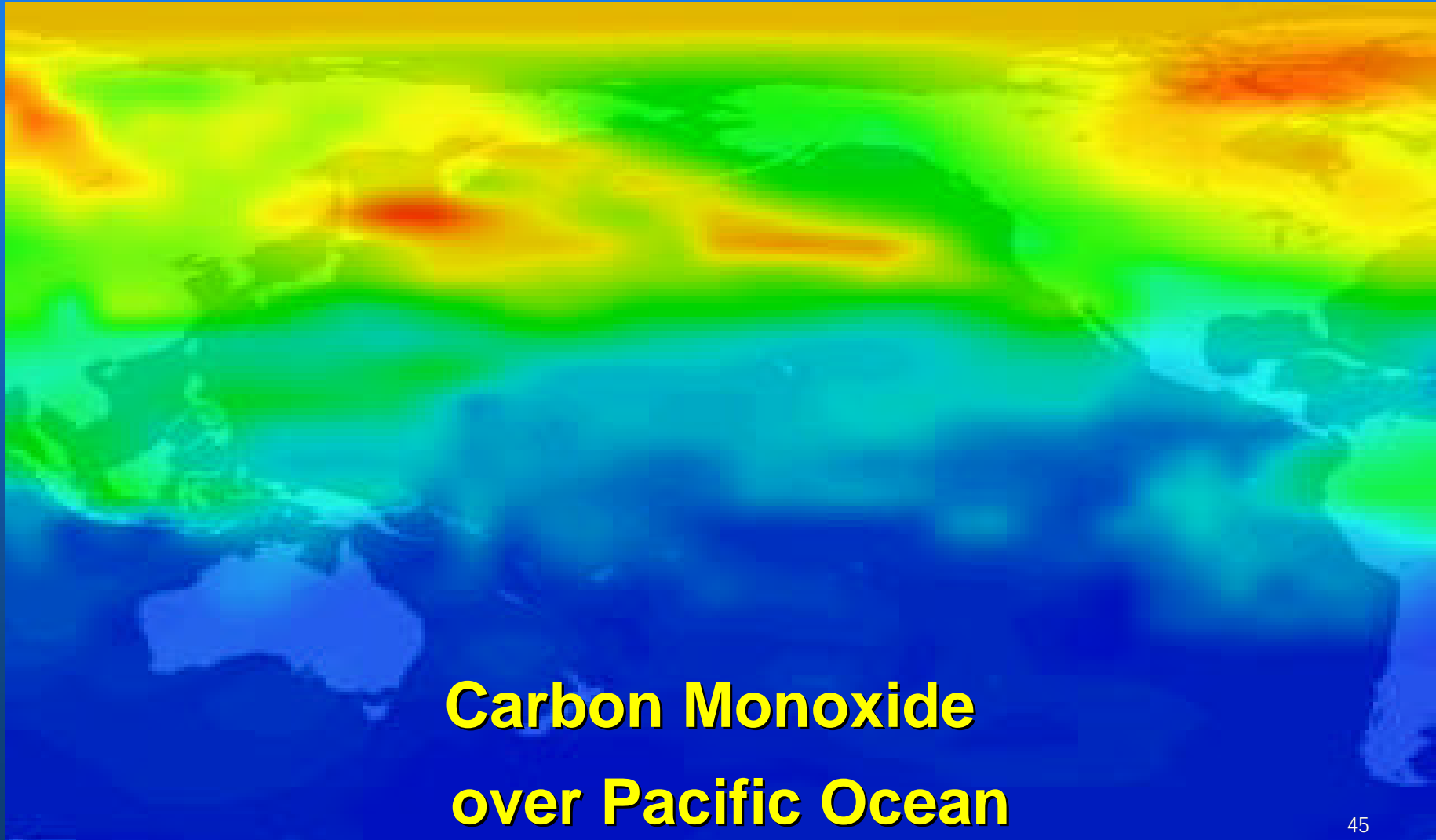
- New burner technology for boiler controls
- Cost-effective: \$900 / ton NO_x, retrofit; \$250 / ton, new boiler



Major On-going Projects

- Solar Crop Drying (Conserval Engineering)
- Autothermal Cyclic Reformer for Hydrogen Production (GE Energy & Environmental Research)
- Battery School Bus (Sacramento Municipal Utility District)

Global Air Pollution



NASA MOPITT March-Dec. 2000

Some Key Research Questions

- How can the greenhouse gas emission inventory be improved?
- What is the role of aerosols in climate change?
- What contributions does global transport play in California's air quality?

On-going Projects



Greenhouse Gases Emissions

- Nitrous oxide
- Hydrofluorocarbons

Black Carbon (BC) Research Projects

- Radiative forcing effect
- Measurement methods and emissions

Environmental Justice



Photos by David Woo, Dallas Monitoring News and Green Action

Completed

- Huntington Park asthma study
- Neighborhood Assessment Program School Monitoring

On-going projects

- Low-cost, easy-to-use air monitoring technologies (3 projects)
- Traffic assessment in the East Bay Children's Respiratory Study

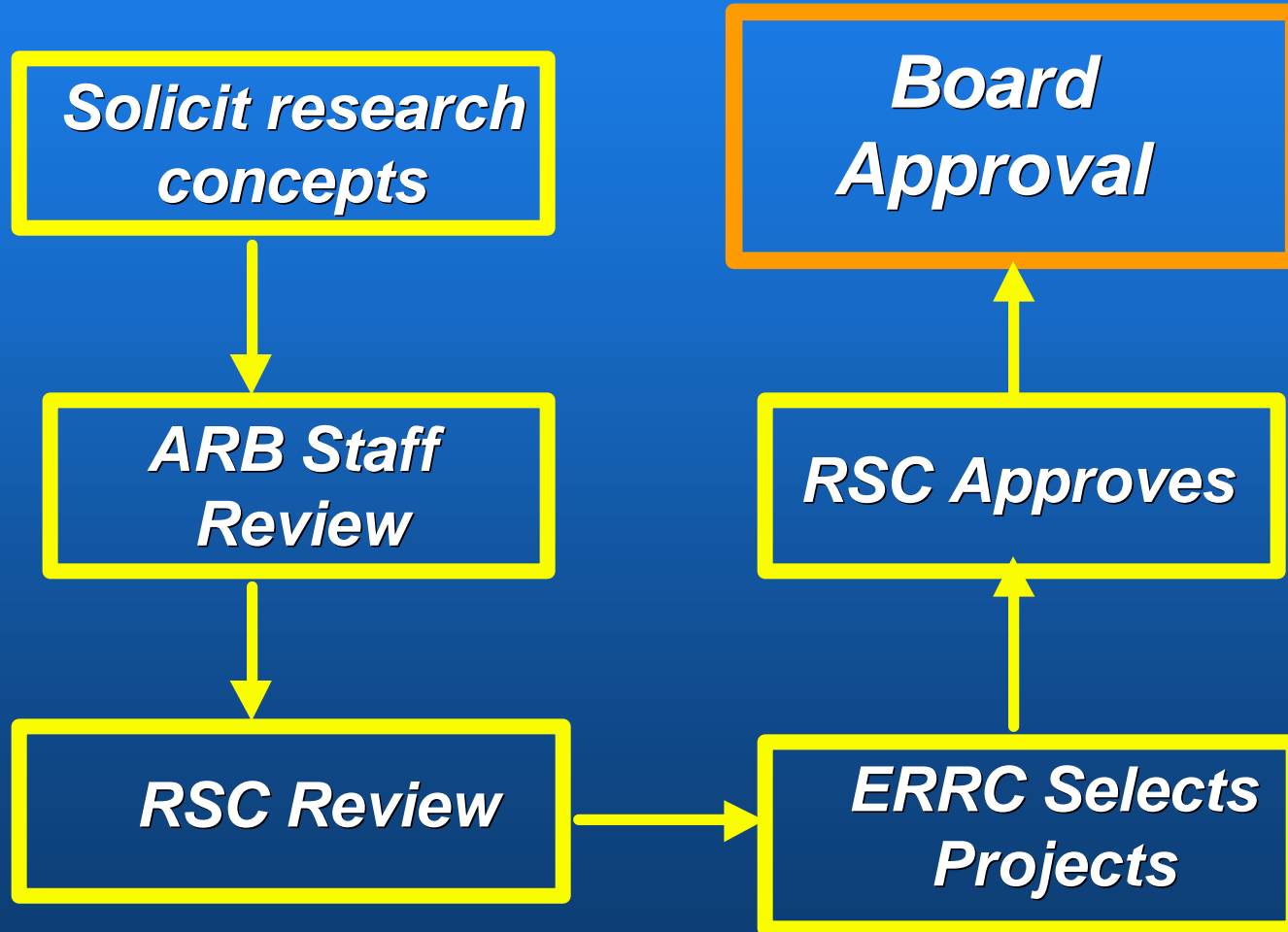
Presentation Overview

- Research Program Overview
- Strategic Plan for Research, 2001-2010
- **Planned Air Pollution Research for 2004/05**



Planned Air Pollution Research Fiscal Year 2004-2005

Research Planning Process



Proposed Research Projects

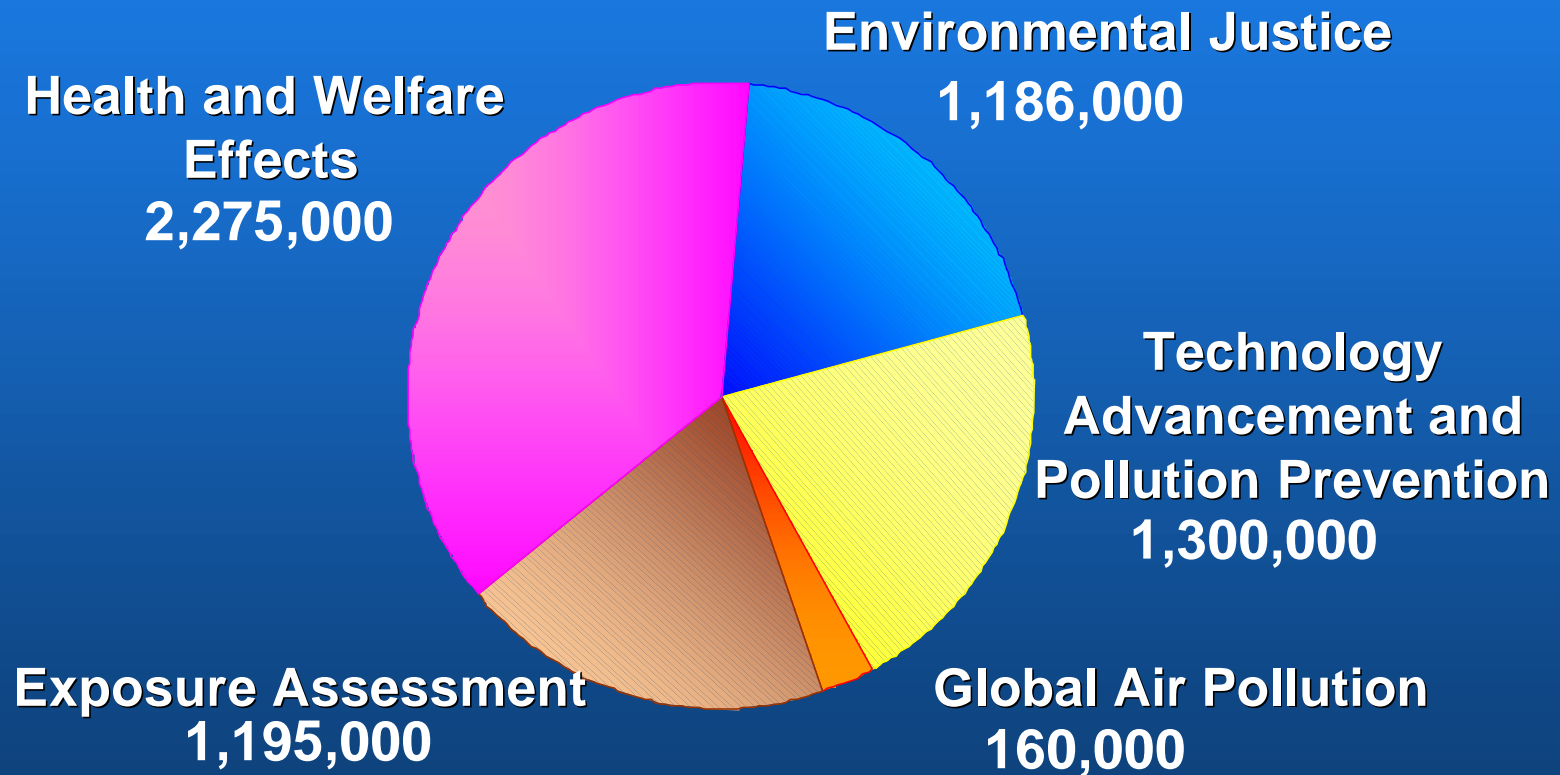
- 22 Recommended Projects
- 5 Research Categories
- Budget Allocations
- Specific Projects

Research Categories

- Environmental Justice (3 projects)
- Health and Welfare Effects (6 projects)
- Exposure Assessment (7 projects)
- Technology Advancement and Pollution Prevention (5 projects)
- Global Air Pollution (1 project)

Research Division Budget

\$6,116,000



Annual Plan Presentation

- 5 categories
- Project listing under each category
- Highlight specific projects
- Recommend acceptance

Environmental Justice Projects

- Integrating cumulative impact and socioeconomic vulnerability into regulatory decision making
- Characterizing exposures in disadvantaged and high traffic neighborhoods
- Effects of aircraft ultrafine particles on local air pollution

Effects of Aircraft on Local Air Pollution



What are the pollution levels in neighborhoods downwind of a major airport?

Health and Welfare Effects Projects

Effects from Sources

- Cardiopulmonary responses from woodsmoke
- Health impacts of PM from indoor sources
- Cardiovascular effects of ultrafine PM during freeway travel

Effects from Pollutants

- Effects of ambient PM in animal models
- Effects of ozone and NO₂ on cardiovascular responses
- Particle phase peroxides: characteristics and effects

Health Impacts of PM from Indoor Sources



To what extent do indoor sources contribute to PM health effects?

Exposure Assessment Projects

Pollutant Characterization

- Particle characterization of PM_{2.5}
- Development of an aerosol tracer technique
- Improve characterization of ambient concentrator

Air Quality Modeling

- Models of ozone and PM formation from power production and during the “Weekend Effect”

Inventory Improvement

- Assessment of Out-of-State Truck Trends
- Improve Activity Estimates for Light-Duty Vehicles
- Speciation Profiles for Commercial Jet Engines

Particle Characterization of PM_{2.5}



**What is the
temporal and
spatial variability
of particle
composition in
various regions in
California?**

Technology Advancement and Pollution Prevention Projects

Agriculture-Related

- Development of Diesel PM Compliance Method
- Identify Off-Road Equipment
- Evaluation of Covered Lagoons and Digesters
- Reduce Fumigant Pesticide Emissions

Compliance Improvement

- Improved Architectural Coatings Test Method

Methods to Reduce Fumigant Pesticide Emissions



How do different
agricultural practices
affect VOC emissions
from
fumigants?

Global Air Pollution

- Long Range Transport: Impacts of Background Ozone and PM

Recommendation

**Approval of the
Planned Air Pollution
Research for Fiscal Year
2004-05**



AIR POLLUTION RESEARCH

California Environmental Protection Agency



Air Resources Board